How to Hide a Ship

"Don't get detected. If detected, don't get targeted. If targeted, don't allow a mission kill. If a mission kill occurs, don't lose the ship."

By Nancy McGuire

In 1943, so the story of the Philadelphia Experiment goes, the U.S. Navy found a way to make a ship invisible. In reality, the Navy was conducting research on making ships magnetically "invisible." That is, the Navy was counteracting distortions in the Earth's magnetic field that a ship normally produces when it moves through the water. The Navy's goal was to prevent its ships from setting off magnetically-triggered explosive mines.

Recently, the Navy has tested emerging high-temperature superconductor (HTS) technology to develop a lighter, more compact, magnetic cloaking device to protect its ships from underwater explosive devices.

Since 1950, the U.S. Navy has lost more ships to mines than to missiles, torpedoes or bombs. To reduce this risk, some Navy ships are equipped with degaussing systems, basically a network of electrical cables that wraps the ship. The electrical current in the cables is calibrated to counteract the magnetic field fluctuations that the ship produces as it travels through the water. Thus, the ship is less likely to set off underwater mines or be detected by hostile forces.

Conventional copper-cable degaussing systems are effective, but they are also heavy, bulky and power-hungry. Although the new superconducting devices will offer no cost savings (at least in the early stages of acquisition), their light weight, compact size, and lower installation costs offer a net advantage aboard a ship. Further, the cost of an HTS system is expected to drop as the production capacity for HTS wire grows.

Because the HTS cables carry a much greater current density than copper, there is a potential 80 percent weight reduction over current copper-cable degaussing systems. For a ship such as the LPD 17-class amphibious transport dock ship, this could translate to a weight reduction of about 125 long tons.

The Office of Naval Research is sponsoring HTS degaussing research at the Naval Surface Warfare Center, Carderock Division, in Philadelphia. The Carderock researchers — Mike Gresco, Brian Fitzpatrick, Jacob Kephart and Michael Robinson — are assessing the feasibility of using this technology, identifying the risks involved, and coming up with the specifications that will make it possible for its use on Navy ships.

Their goal is to push the technology to a level of readiness that will allow the Navy to incorporate it into an acquisition program. The Carderock group has submitted four patent disclosures to date, with more to follow.

On June 8, the Carderock group sponsored an industry day. Representatives from various military contracting companies and manufacturers of superconducting materials got a look at the operational one-loop demonstrator system and took a virtual tour of the technical drawings for an upcoming two-loop system. The existing demonstration system, which uses commercially available components, has been operational since February. It uses gaseous helium to maintain the single 50-meter loop at an optimum operating temperature of about –220 C.

Despite a cooling problem that has been identified and will be addressed, the system has achieved 300 amp-turns of magnetic flux to date. After this problem is corrected, the system is expected to more closely approach the predicted flux of 1200 amp-turns.

The system has been built to accommodate additional superconducting wires that will bring the flux to the level required for an operational ship system. It uses the first-generation HTS material bismuth strontium calcium copper oxide because of its availability and price.

Future systems may use the second-generation yttrium barium copper oxide superconductors, which can operate at higher temperatures and reduce refrigeration requirements.

In April 2006, the American Superconductor Corp. announced that it had successfully demonstrated a full-scale HTS-based degaussing cable. Its laboratory setup uses a gaseous helium-cooled 40-meter bismuth calcium copper oxide HTS cable to produce 4100 amp-turns, a magnetic flux that is comparable to the existing copper-based degaussing cables used in military ships.

However, the HTS cables operated on 0.5 volts, compared with the 500 volts needed for copper degaussing coils. The HTS cable weighs about 20 percent less than conventional copper cables.

These factors combine to reduce the installed cost of the HTS degaussing system to about 40 percent compared with a similar copper coil system.

At present, the Carderock group is adding amp-turns to its system and checking the magnetic performance of the system, according to Fitzpatrick. The refrigeration system must be capable of maintaining the entire length of the cables at the proper temperatures, while withstanding the shocks and vibrations that are typical of a shipboard environment.

Nancy McGuire is with the Office of Naval Research public affairs office.

CHIPS

Project engineer Brian Fitzpatrick, from Advanced Machinery Technology Naval Surface Warfare Center, Carderock Division, with the framework for a new HTS two-loop system.